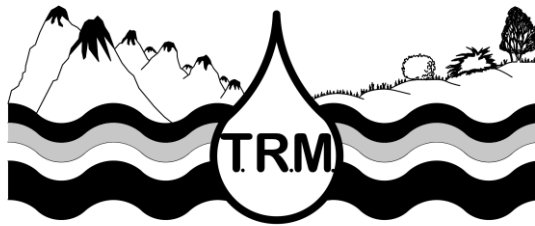




## The River Mile Framework



**Ninth - Twelfth Grades**

**TRM  
Connections  
to  
Washington State  
Revised Science Standards**

Working Model  
2/12/2010



**TRM Essential Question:** How do we simultaneously use and protect our watershed?

**Guiding Questions:** How do we investigate TRM to validate or contribute to our understanding of theories used to explain its natural systems? For my Senior Project, what could I do to demonstrate that one person can make a difference?

### **EALR 1 - Systems: Predictability & Feedback**

Create realistic models with feedback loops and recognize that all models are limited in their predictive power.

- Represent TRM system with a diagram specifying components, boundaries, flows and feedbacks. Describe relevant subsystems (e.g., plants, animals, landforms, water quality and quantity, human use and impact).
- Determine how subsystems create "Positive Feed back" which increases the disturbance to TRM system (e.g., 1. Climate change causes Earth's ice caps to melt, reflecting less energy to space, increasing temperature; 2. Changing lake levels resulting from Grand Coulee Dam operations causes contaminated beach sediment exposure to winds and transport of toxic dust in the air resulting in increased exposure for human, animals & plant populations to chemicals).
- Determine how TRM subsystems demonstrate "Negative feedback" which reduces the disturbance to TRM system (e.g., tree canopy absorbs sunlight producing leaf growth and oxygen. Leaves provide food for animals which exhale CO<sub>2</sub> that is then used by plants).
- Describe how TRM system functions with respect to balance & flow between plant, animal, and non-living sub-systems. Determine whether a state of equilibrium is static or dynamic, inflows equal outflows, within TRM food web. Identify information needed to make your model predictive of future populations (e.g., rate of spread of non-native plants that have no native consumer).

### **EALR 2 - Inquiry: Conducting Analyses & Thinking Logically**

Expand and refine skills and abilities of inquiry to gain a deeper understanding of natural phenomena.

- Generate and evaluate a question about TRM that can be answered through a scientific investigation.
- Plan and conduct a scientific investigation choosing a method appropriate to your question about TRM.
- Collect, analyze, display data, draw conclusions, analyze



	<p>alternatives, write detailed lab report, and formulate one or more hypothesis based on a model, or theory of a causal relationship. Evaluate the investigation and develop a scientific theory about TRM question that illustrates logical reasoning, creativity, testing, revision, and replacement of prior ideas in the light of new evidence.</p> <ul style="list-style-type: none"><li>• Provide appropriate citations for ideas, findings, &amp; information.</li></ul>
<b>EALR 3 - Application: Combining Science &amp; Technology to Solve Problems</b>	
Transfer and apply abilities in science and technological design to develop solutions to societal issues.	<ul style="list-style-type: none"><li>• Critically analyze scientific information in current events to make personal choices or to inform public policy decisions.</li><li>• Describe ways that scientific ideas have influenced society or the development of differing cultures around Lake Roosevelt. For example, building Grand Coulee Dam to produce hydroelectric power and store river water for times of need was seen as an innovation by the majority populations. The Colville &amp; Spokane Tribes held cultural values that did not include management or control of natural phenomena. Need for electric power by the majority resulted in reduction or total elimination of androgynous salmon populations who could not navigate the dams. Increased water levels covered fish spawning grounds, raised water temperatures and changed the levels of dissolved gasses. Above are examples of the unintended consequences of technology. Compare alternative solutions and considering trade-offs. What could be lost or gained by removing dams to increase salmon spawning? What would be the new unintended consequences?</li><li>• Work with other students and generate ideas to solve a problem you have identified at TRM. Identify criteria and constraints, research the problem and generate several possible solutions. Choose the best solution, create a model of the final design and devise a way to test it. Use proportional reasoning, computers, probes, and collect data.</li><li>• Consider the unintended consequences of your innovation. How could you determine the cost benefit ratio?</li></ul>



**EALR 4 - Physical Science: Force & Motion**  
**Newton's Laws**

Multiple forces affect an object's motion in predictable ways. These affects are explained by Newton's Laws.

- How can you use Newton's Laws to measure the difference in the flow of rivers between the fall & spring? River flow is described by CFS (cubic feet per second)
- Calculate the average velocity of the river flow, speed and direction, at TRM. How do land formations change the velocity of the river? Scientists have tried many different ways of reinforcing river shorelines from erosion. Some attempted solutions (e.g., sandbags, concrete walls & rip rap) have actually increased the rate of erosion downstream. Explain river bank erosion using Newton's Laws. Can you use Newton's Laws to develop a solution to river bank erosion? Why do plant roots help reduce bank erosion? Research other solutions (e.g., soil nailing; basket, stacked & mattress gabions; tree revetment, coir geotextile role and brush mattress). Consider the cost benefit ration of different solutions.
- Electric current flowing in a wire will create a magnetic field. Moving a magnet near a wire will cause an electric current to flow in the wire. Research the process used at a local dam to generate electricity using hydropower.

**EALR 4 - Physical Science: Matter: Properties & Change**  
**Chemical Reactions**

Atomic structure accounts for atoms ability to combine and to produce compounds. These changes maybe physical chemical or nuclear.

- Describe the relative charges, masses, and locations of the protons, neutrons, & electrons in an atom of hydrogen and an atom of oxygen.
- Explain how hydrogen & oxygen bond together to make a molecule of water, one oxygen atom shares electrons with two hydrogen atoms.
- Explain how water can change from liquid to solid to gas?
- Research covalent compounds occurring when water and other elements or molecules bond. Explain transportation of toxic chemicals from a point source to downstream sediments?



	<ul style="list-style-type: none"><li>• Give examples of common solutions. Explain the difference among processes of dissolving, melting, and reacting.</li><li>• How is oxygen transported in water? What roles do water movement, temperature &amp; depth play in the amount of dissolved oxygen (DO) available for aquatic life?</li><li>• Explain the meaning of a chemical formula for <math>H_2O</math> and <math>CO_2</math>, Find the chemical formula for chemicals of interest that create water quality concerns (e.g., phosphates, nitrites, and PCBs).</li><li>• Predict the change in pH of adding amounts of lead, copper or arsenic to an aqueous solution.</li><li>• Describe how carbon atoms form covalent bonds to make large molecules (e.g., plant &amp; animal tissue). Describe the properties of a molecule of carbon dioxide (<math>CO_2</math>). Why is <math>CO_2</math> significant in the discussion of climate change? What are sources of <math>CO_2</math>?</li><li>• Predict the effect of a change in temperature on the rate of water evaporation or freezing. Create a data table to model the effect of temperature changes of + or -1, 5, 10, 15, and 20 degrees. Create a model predicting plants &amp; animals survival.</li></ul>
<b>EALR 4 - Physical Science: Energy: Transfer, Transformation, &amp; Conservation Transformation &amp; Conservation of Energy</b>	
Energy and matter interact resulting in energy transfers & transformations. There are multiple forms of energy.	<ul style="list-style-type: none"><li>• Describe a situation at TRM in which energy is transferred from one place to another. Explain how energy is conserved. For example, wind blowing at TRM moves the branches of a tree. Wind slows from interaction with the tree and tree branches absorb the energy and begin moving or break under the pressure.</li><li>• Describe a situation at TRM in which energy is transformed from one form to another (e.g., A gray squirrel eats the seeds from a ponderosa pine cone. The pine cone seeds, potential energy, will not produce new trees but do produce chemical energy in the squirrel's metabolism).</li></ul>



	<ul style="list-style-type: none"> <li>How can you calculate the kinetic energy of waves on TRM shoreline? The kinetic energy of an object is defined by the equation <math>E_k = \frac{1}{2} mv^2</math>. Waves transfer energy when they interact with matter. Waves can have different wavelengths, frequencies, and amplitudes and travel at different speeds. The velocity of water is described as CFS, cubic feet per second.</li> <li>Investigate the effect of waves created by boats travelling at identified speeds and the impact of the wake on the shoreline. What impact, if any, does increased wake have on the transfer of toxic substances distributed in shoreline sediment? What impact does wake have on the degradation of spawning grounds for fish?</li> </ul>
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#### **EALR 4 - Earth & Space Science: Evolution of the Universe**

Physical principles apply to the origins and development of the Earth and the Universe.	Not applicable to TRM at this level.
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#### **EALR 4 - Earth & Space Science: Earth Systems, Structures, & Processes Energy in Earth Systems**

Energy from the Sun drives our weather system and climate, while energy from Earth's interior drives the rock cycle and crustal plates.	<ul style="list-style-type: none"> <li>Compare fall and spring temperature samples take at TRM. Explain the seasonal climate variation due to tilt of earth's axis. Draw a diagram to show the changing angle of the sun's rays toward TRM to support your explanation.</li> <li>Draw a model to show the impact of greenhouse gasses in affecting the weather patterns. How do land formations, including Lake Roosevelt, influence TRM weather?</li> <li>Describe the different forms taken by carbon and nitrogen and the reservoirs where they are found on Earth (e.g., carbonate rocks such as limestone, coal, oil, in the atmosphere as carbon dioxide gas and in the tissue of all living organisms).</li> <li>Identify renewable and non-renewable resources. Explain how human use of natural resources stress natural processes and link that use to a possible long term consequence.</li> </ul>
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#### **EALR 4 - Earth & Space Science: Earth History**

##### **Evolution of the Earth**

<p>Evidence provided by natural radioactive material has made it possible to determine the age of different structures and of Earth as a planet.</p>	<ul style="list-style-type: none"><li>• Observe TRM and interpret current rock formations. Consider which earth processes may have caused these landforms (e.g., erosion, deposition, scraping of terrain by glaciers, floods, volcanic eruptions, or tsunamis).</li><li>• Construct a possible timeline showing the development of the rock formations.</li><li>• Describe factors that change climates over long periods of time and cite methods scientists have found to gather information on ancient climates.</li><li>• What can you learn about the changes on TRM over the past 100 years? Research photos, newspaper and eyewitness accounts and scientific data that describes the changes in plant and animal populations, landforms and river changes due to the introduction of Grand Coulee Dam. How can these changes be used as a model to understand changes over geologic time?</li></ul>
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#### **EALR 4 - Life Science: Structures & Function of Living Systems**

##### **Processes within Cells**

<p>Cells contain the mechanisms for life functions, reproduction, and inheritance.</p>	<ul style="list-style-type: none"><li>• Explain the importance of photosynthesis to plants, animals and humans. Explain photosynthesis using equations to illustrate the rearrangement of atoms.</li><li>• Explain how the process of cellular respiration is similar to burning fossil fuels (i.e., combustion of carbon containing compounds to transform chemical energy into different forms of energy).</li><li>• Draw, label, and describe the functions of components of essential structures within cells (i.e., cellular membrane, nucleus, chromosomes, chloroplasts, mitochondrion, and ribosome).</li><li>• At TRM, select a producer and consumer to study. Identify the plant and animal and research the essential cellular functions of both the plant &amp; animal and the flow of energy. Illustrate the</li></ul>
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	<p>process of reproduction for both plant and animal. Identify the similarities and differences in mitosis and meiosis. Show how the process of genetic recombination results in differing characteristics in the offspring. Predict which characteristics will support survival of each species at TRM?</p>
<b>EALR 4 - Life Science: Ecosystems Maintenance &amp; Stability of Populations</b>	
<p>A variety of factors can affect the ability of an ecosystem to maintain current population levels.</p>	<ul style="list-style-type: none"><li>• Explain how plants and animals cycle carbon and nitrogen within TRM ecosystem.</li><li>• Create a model to show how matter cycles &amp; energy flows in TRM ecosystem &amp; results in the formation of chemical compounds &amp; heat.</li><li>• Evaluate the conditions necessary for rapid population growth of a species (e.g. increased temperatures allow mountain pine beetles to survive the winter and infest ponderosa pine).</li><li>• Calculate or find statistics on the population density of an organism at TRM. (e.g., <b>fish</b>: kokanee, trout, walleye, largemouth bass; <b>animals</b>: mule deer, coyote, rabbits, squirrels; <b>birds</b>: bald eagle, red-tail hawk, crow, starling, nuthatch, <b>plants</b>: alum root, bitterbrush, sagebrush, balsam root, blue bunch grass, hard fescue, lupine, &amp; <b>trees</b>: alder, Douglas fir, Ponderosa pine, black cottonwood, willow).</li><li>• Explain the factors, including matter and energy, in TRM environment that limit growth of plant and animal populations.</li><li>• Draw a systems diagram to illustrate and explain why introduced, non-native, species often do poorly and have a tendency to die out, as well as why they sometimes do very well and force out native species (e.g., toadflax, gorse, hogweed, knapweed, musk thistle, orange hawkweed, parrot feather, purple loosestrife and more).</li><li>• Research TRM and determine how it is affected by loss of biodiversity. Which plant and animal species at TRM are in danger? Which are thriving?</li></ul>





## The River Mile Framework: Instructional Connections Grades 9-12

	<ul style="list-style-type: none"><li>How can the concept of sustainable development, substituting renewable for nonrenewable resources, recycling, and using fewer resources, be applied at TRM? Consider the implications for mining, pulp mill, fisheries, and hydroelectric industries.</li></ul>
<b>EALR 4 - Life Science: Biological Evolution</b> <b>Mechanisms of Evolution</b>	
The underlying mechanisms of evolution include genetic variability, population growth, resource supply, and environment.	<ul style="list-style-type: none"><li>Classify organisms at TRM, using similarities and differences in physical and functional characteristics. Explain variation or related organisms in terms of biological evolution. (i.e., bird beak variation based on food supply).</li><li>Explain biological evolution as the consequences of the interaction of four factors: Population growth, inherited variability of offspring, finite supply of resources, &amp; natural selection by environment of offspring better able to survive and reproduce. Predict the effect on a species at TRM if one of the four factors changes. Describe the effect on a species caused by human technology and interaction?</li></ul>
<b>Stewardship of our River Mile</b>	
	What is the relationship between the factors impacting TRM? What is my role now in protecting, preserving and enjoying TRM site? Is there evidence of vandalism? What actions can we take to restore native species and their habitat?

### Units of Study that can be reinforced by visits to The River Mile location are:

**Physical Science:** Composting: the generation of heat for decomposition, pH, water, generation of electricity by hydroelectric plants, Velocity of the river, Water use how much & where; Water polarity, water quality, Why is water a universal solvent? Energy and motion, Transference of energy; Chemical interactions

**Earth Science:** GPS & GIS mapping, Landform changes (e.g., sand bar seasonal changes, beach cross section, and history of human impact on the river

**Chemistry:** Water Quality Chemical testing, Homes & lawns use of nitrates and cleaning substances House boats parks marinas oil spills & gas, Atom molecules, energy levels of atom, why and how jump, bonding, periodic table, Experiments, density, pull out materials,



## The River Mile Framework: Instructional Connections Grades 4-5

wax metals to purify, chemical reactions, solutions, Identify molecule by burning flame test

**Biology:** Life Cycles, Cells to organisms, Micro systems (e.g., rock garden), Native plants & animals compared to non-native, invasive and noxious plants & animals. Identification, preservation and restoration mapping habitats, fisheries, triploid red band trout, Animal waste on shorelines, hunting & fishing, sturgeon recovery initiative, trout; heredity, genetics, water quality, Eco systems (

**FAA:** Honeybees & pollination, Soils, horticulture, agriculture,

**Environmental Science:** Current Events and local issues, Global patterns, Earth Day, Buy locally at farmers markets Recycling everyday focus, ecological footprint, online calculation

Facing the future - Global issues of sustainability; Developing and developed country. Identifying ineffective practices; Watershed, River Mile; Current Events and local issues, pandemic, flu, global patterns; Earth day; cross age tutoring.

### NPS Resource Managers Related Projects & Programs: